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FROM
EXPERIMENT STATIONS

SEASON 1955-56

NYASALAND

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NYASALAND

PROGRESS REPORT FOR THE SEASON 1955-56

BY

J. M. MUNRO.

COTTON SEASON.

Province	*Type of crop*	*Legal sowing dates*	*Harvest*	*Legal uprooting date*
Southern, Central	Summer	15 Nov.-7 Jan.	Apr.-July	31 July
Northern	Winter	16 April-15 June	Oct.-Dec.	15 Jan.

INTRODUCTION.

General and Staff.

The Chitala experimental station, near Domira Bay, was opened by the Empire Cotton Growing Corporation in 1929-30. A survey of the potential cotton growing areas of the country had shown that the plains lying to the south and south-west of Lake Nyasa offered the greatest scope for expansion of cotton acreage; Chitala was sited in this area.

For a variety of reasons, cotton has not proved to be a popular crop in this area, despite its advantages; the Lower River continues to produce the bulk of the crop. It has, therefore, been felt for some time that the cotton experimental station should be sited in the Lower River. The merits of a number of different sites have been considered by the Department of Agriculture and the Empire Cotton Growing Corporation, and it was finally decided that the existing Departmental station at Makanga should become the centre for work on cotton in place of Chitala.

Mr. J. M. Munro arrived at Chitala from Tanganyika on 4th October 1955, to take over the cotton work in Nyasaland. Mr. H. C. Ducker, who had spent 33 years in the country, 30 of them as Cotton Specialist in charge of the Corporation's work, left Chitala on 5th November on leave pending retirement. Mr. Munro also left Chitala in November to take charge of the Makanga station.

The Chitala station was handed over to the Department of Agriculture on 1st January 1956, along with such Empire Cotton Growing Corporation equipment as was not required at Makanga. Some 20 acres of land will be made available each year at Chitala for cotton experiments, if required, to supplement the programme at Makanga.

Mr. R. Soar, the Corporation's farm manager at Chitala since 1951, left for South Africa on 3rd July 1956, on completion of his contract. Mr. I. Edwards, Agricultural Supervisor, was transfered to Chitala in June to manage the station.

I should like to record my appreciation of the help and advice received from Mr. Ducker in October, during the handing-over period; the assistance of Mr. Soar at Chitala during the season; and of Mr. S. T. Hoyle, Chief Agricultural Research Officer, in connection with the handing-over of Chitala to the Department of Agriculture.

Makanga is situated 3 miles north of Chiromo, where the Shire and Ruo rivers meet. It is on the south-eastern edge of the main cotton growing area of the country, at an altitude of about 200 feet above sea level. The area of the station is 100 acres, comprising 41 acres run on an 8-course rotation; 14 acres of long-term experiments; 17 acres of irrigation; the remainder being occupied by roads, buildings, uncleared land, etc.

A further 100 acres adjoining the station were purchased by the Government in February 1956; 33 acres have been cleared this season.

Two of the four new houses built by the Cotton Marketing Board (now the Agricultural Production and Marketing Board) have been made available for the use of the Cotton Specialist and the Farm Manager. The house on the farm has been converted into an office and laboratory, and a cotton seed store has been built alongside it. A new cotton store, with facilities for ginning, has been put up near the farm buildings, and two of the six additional African staff houses planned have been completed.

Mr. A. R. K. Gibbs, Agricultural Supervisor, took over Makanga from Mr. W. G. Plaistowe, Agricultural Officer, in August 1955; he resigned in May 1956. Mr. D. F. Collings, Agricultural Supervisor, arrived from England on 16th May to take over as farm manager.

Visits.

Mr Munro visited Namulonge in December 1955, and attended the meeting of the Namulonge Advisory Board on 8th and 9th December as the Nyasaland representative.

Mr. E. O. Pearson, formerly of the Empire Cotton Growing Corporation, and now Assistant Director of the Commonwealth Institute of Entomology, paid a visit to Nyasaland from 29th May to 10th June 1956.

H.E. The Governor, Sir Robert Armitage, paid a short visit to Makanga during his first tour of the Southern Province in August 1956.

Weather.

Chitala Station.—Practically all the planting was completed in the week 11th to 17th December 1955, when 2·37 ins. of rain fell. Seed sown towards the end of the week gave only partial germination, much of it lying dormant until the end of the month. There were over ten inches of rain in both January and February; March was wet, and late rains continued up to the end of April. The total from November to May inclusive was 38·32 ins., rather above average.

Makanga Station.—The season as a whole was dry, and planting conditions difficult. The first heavy rains came on 8th December, but were short-lived, and no further planting could be done until the last week in December. Between 3 ins. and 5 ins. of rain fell each month from December to April, giving steady but not excessive growth.

Despite the rather dry condition at Makanga, the station was inundated by floods from the Ruo river on 6th April. These were the result of the passage of cyclone "Edith" across Nyasaland, causing exceptionally heavy rain in the Ruo catchment area, when the soil was already saturated. The river flow reached catastrophic level, in the sense in which the term is used in the report on the Shire Valley Project; that is, it would not be expected to occur more than once in a hundred years.

Fortunately, the cotton seed stocks were duplicated at Chitala, and there was no serious loss of breeding material. The cotton on Makanga which was under water for more than 24 hours was completely killed, and only the few bolls which were already mature before the flood produced any cotton.

The Cotton Season.

Northern Province.—The 1955 crop of around 500 bales was much below average. Unusually early and severe floods in December resulted in the loss of much unpicked cotton in the field. Rats, which have been a serious pest in Karonga for many years, were responsible for a great deal more damage than usual to cotton this season, and a concerted drive to reduce their numbers is being made.

Central Areas.—Planting rains fell mainly in mid-December, which meant a short planting season. The acreage was estimated to be about 70% of the previous year's figure. Red bollworm caused severe shedding of buds in early March round the Lake shore, and cotton planted in January lost practically all its potential crop. Later in the season, stainers caused widespread damage in all areas, and bacterial blight was prevalent in both the blackarm and bollrot phases.

The combination of reduced acreage, red bollworm, stainer and bacterial blight has resulted in a very poor crop.

The small but promising crop from the Lisungwe area in the Upper Shire Valley escaped damage from red bollworm, but stainers and bacterial blight reduced yields to less than half the earlier estimates.

Lower River.—The main cotton area around Ngabu was planted under good conditions, but on some soils dry weather following germination reduced stands considerably. To the north and south of the main area planting conditions were difficult, with late and scanty planting rains.

As in the central areas, a heavy stainer attack from March onwards was reinforced by locally severe bacterial blight. This was aggravated by the late rains, which also encouraged secondary infections in prematurely split bolls. Up to 75% of the crop set was estimated to have been shed, opening was poor, and a high proportion of the cotton brought to market was second grade.

Seed Cotton Purchases.—The following figures, kindly supplied by the Agricultural Production and Marketing Board, show the extent of the fall in production compared with the previous season.

Seed Cotton Purchases in short tons.

Province	*1955 crop*		*1956 crop*	
	1st Grade	*2nd Grade*	*1st Grade*	*2nd Grade*
Northern	313	5	287	9
Central	975	190	304	151
Southern	4877	2228	1392	1090
Total	6165	2423	1983	1250

General Account of the Work for the Season.

Cotton Breeding.

CLB and CL20.

Over the past few years, CL20 has shown consistent superiority over CLB, the commercial cotton of Nyasaland, in staple length and spinning quality (cf. Table 2). CL20 yarn has shown no undesirable characteristics, such as neppiness, which might indicate that its lint is too long or fine for conditions in Nyasaland; it seems that the country can produce a cotton of a longer staple than the present 1 in. of CLB.

CL20 does not appear to be inferior to CLB in jassid resistance, and trial results show no consistent differences in yield or ginning percentage. The rather shorter and more compact habit of CL20 is a desirable character in the very lush growing conditions of this country. The Department of Agriculture has decided to introduce CL20 in place of CLB in the Central and Southern Provinces, pending the testing and multiplication of the Albar 51 strains (see later); all the seed produced in the Fort Johnston district and at Rivi Rivi this year will be planted

at Toleza and in the Lisungwe area next season. A suggestion that CL20 may be unsuitable for the Lower River is not confirmed by past trial results; but an extensive series of trials will be carried out there next season to compare its performance with that of CLB and the Albar 51 strains.

The CLB selections made last year for high ginning percentage have been discarded to make way for types with longer lint, except for a few progenies with other characters of interest; these progenies may be used in the crossing programme with Albar 51.

Albar.

Bacterial blight has been an important factor in the poor crop this season, and breeding for resistance is considered a very worthwhile project. At Makanga, the early planted (15th November) irrigated plots had already yielded over 600 lb. per acre of seed cotton before the flooding on 6th April. They were planted with CLB, and 62% of the cotton was grade 2; almost all the damage was due to bacterial boll rot. Although these plots were irrigated, similar conditions can occur in a wet season without irrigation. At Chitala, the difference in appearance between the CLB and the Albar strains and crosses was very striking—the Albars not only opened better, but also set more fruit. The variety trial at Chitala (Table 1) confirmed those differences in terms of yield for the second year in succession; the six Albars tested out-yielded CLB by amounts ranging from 25% to 48%.

These Albars are selections from Albar 51 brought from Namulonge in 1953, which, without any crossing or local selection, have done extremely well in competition with the local variety both last season

Table 1.

Cotton Variety Trials.

Variety	*Chitala 1956*		*Ngabu 1956*	*Mean of 1955 trials*	
	Lint in lb./acre	*Gin %*	*Gin %*	*Lint in lb./acre*	*Gin %*
CLB	159	36·4	38·0	126	31·9
CL20	178	35·4	36·4	127	31·3
Albar 625	194	36·8	35·2	242	32·9
,, 629	226	37·8	36·6	192	34·9
,, 637	220	37·6	38·8	260	34·2
,, 639	226	37·4	34·6	296	33·6
,, 640	230	38·4	36·4	215	34·3
,, 645	212	40·0	38·2	239	36·5
S.E.	± 8·9				
Sign. Diff. (P=·05)	25				

Note: Ginning percentage is determined on a hand-operated roller gin, as a saw gin is unsuitable for small samples. Roller ginning has been found to give a figure about 2% higher than saw ginning.

and this. Unless the 1957 trials show a complete reversal of form, one of these strains will replace CLB and CL20 as the standard variety in central and southern Nyasaland. They have not yet been tested in North Nyasa, where dry season cropping makes it less important to have resistance to bacterial blight.

TABLE 2.

LINT AND YARN CHARACTERS.

Chitala and Makanga variety trials—1955.

Variety	*Effective length 1/32"*	*Count × strength product*	*Yarn appearance*
CLB	36·5	1968	3·0
CL20	39·5	2276	2·5
Albar 625	40	2131	2·5
,, 629	39	2066	2.0
,, 637	41	2189	2·5
,, 639	38·5	1994	3.0
,, 640	39·5	2122	2.75
,, 645	39	1970	2·5

The Albar 51 strains lie between CLB and CL20 in spinning quality (Table 2). Jassid resistance is similar to that of CLB. A637 has the best overall record, and is to be multiplied as far as possible on the Toleza farm of the Agricultural Production and Marketing Board in 1956-57. Two others will be grown on a smaller scale at Makanga and Chitala, and the final decision on the best strain will be made next year.

Albar Crosses.

Last season, selections were made from two panmixis bulks constituted in 1952—Albar 49 × CL20 and Albar 49 × BP52 × CL20. These were grown in progeny rows this year; there appeared to be segregation into two main habits of growth, but a closer study of this was interrupted by the floods. A selection of about 120 progenies showing the highest lint index has been made, and as many as possible will be tested in trials next season, with particular attention to any correlation between habit and performance.

Breeding for resistance to bacterial blight will be further developed by selection in these progenies, with field testing of resistance by stem inoculation; and by a new series of crosses, using the best Albar 51 strains instead of Albar 49.

Long Staple Uplands.

The long staple uplands being tested at Karonga in the Northern Province were again outyielded by CLB from the Karonga district;

yields per acre were poorer than last year as a result of early flooding and rat damage. BP52 showed up better than last year, but the two strains from the Eastern Province of Tanganyika are the most promising of the imported varieties. Yields are given in Table 3, together with the spinning test results on the 1954 crop.

Table 3.

Karonga Long Staple Upland Variety Trial.

Variety	*1955 trial*		*1954 trial*		
	Lint in lb./acre	*Gin %*	*Effective length 1/32"*	*Count × strength product*	*Yarn appearance*
CLB Karonga Local	412	32·8	36·5	2000	3
CL20 ex Chitala	294	33·0	38·5	2298	2·5
CLA ex Tanganyika	352	31·8	40	2212	3
47/10	339	30·6	41	2380	3
BP52	340	32·6	39·5	2518	2·5
C(50)20 Wilds No. 11	197	34·8	44·5	2600	3
S.E.	± 20·6				
Sign. Diff. (P=·05)	58				

Ginning Outturn.

The high proportion of light seed found in all samples from the Central and Southern Provinces has undoubtedly affected the ginning percentages shown in Table 1, which are unusually high in both trials. While they have some value in comparing one strain with another, they provide no further evidence on the differences in ginning outturn between the two Provinces.

Cross Pollination.

In each of three CLB bulk plots, single ridges were planted with redleaf cotton, kindly supplied from Namulonge. Seed was picked from individual ridges of CLB, up to 20 drills on either side of each redleaf row; samples of 500 seeds were sown from each of these ridges. Only 2 redleaf seedlings appeared, both occurring in one sample (about 300 seedlings) from a ridge adjacent to a redleaf cotton row. The remainder were all true to type. The amount of cross-pollination taking place between adjacent cotton ridges at Chitala appears to have been negligible.

Pests and Diseases.

Red Bollworm, Stainers and Bacterial Blight.—These are discussed by Mr. E. O. Pearson in the report of his visit to Nyasaland, extracts from which appear after this report. We are indebted to the Colonial Office and the Nyasaland Government for permission to reproduce parts of this report, as well as to Mr. Pearson himself.

Jassid.—Jassid was or had been present in nearly all the cotton visited in the Central and Southern Provinces during the season, and was seen as early as January in large numbers in some parts of the Lower River. Typical discoloration of the leaves was general later in the season, but only rarely was the damage serious enough to cause distortion of the leaves. Severe damage was, however, noted in one or two fields near Tengani. In Lisungwe the main attack was late, and caused some distortion of the upper leaves of the plants; some late planted cotton was probably checked in growth.

A higher standard of jassid resistance is desirable, although the present standard seems to be just adequate for the conditions. Plots at Chitala planted with strains from the Eastern Province of Tanganyika were markedly more susceptible than the other varieties being grown.

Helopeltis and Apian Weevil.—Some local damage was caused, but these and other pests and diseases were of very minor importance.

Seed Dusting.—A trial to test the effect on yield of the standard seed dressing with "Perecot" dust was laid down at Chitala, but an examination of the seedlings at about six weeks old showed no leaf or cotyledon lesions due to bacterial blight in either the treated or the untreated plots. Seed-borne infection had in this case apparently been absent or ineffective, and later infection appeared to occur equally in both treatments; there was no significant difference in yield at the main picking.

Irrigation.

The irrigated land at Makanga is intended for preliminary trials of the crops which may play a part in the agricultural pattern of the Lower River as the Shire Valley Project develops. As a result of the floods, however, the season was a failure; most of the wet season (summer) crops were lost, and it was impossible to get land ready in time for any planting in the 1956 dry season.

Under irrigation, it is possible to plant wet season crops in good time, independent of the planting rains. The early planted cotton mentioned earlier in this report gave 600 lb. per acre of seed cotton by the beginning of April. A maize crop planted at the same time, 15th November, yielded over 5,000 lb. per acre of fresh cobs; these cobs were damaged in the floods, but the yield of grain can be estimated at around 4,000 lb. per acre.

Twenty varieties of sugar cane were established in small plots in December 1954 and January 1955. These survived the flooding without damage, and the first cut was taken in July 1956. Yields of eight varieties, estimated from sample weighings, exceeded 50 tons per acre of cane. Most of these had already flowered before cutting, and estimates of sugar content might have been affected; samples will be taken for this purpose prior to the next cutting.

Husbandry and Rotation Crops.

Yields of seed cotton and maize at Makanga after the floods gave no measure of the crop responses to experimental treatments, but stalk weights were recorded in two trials which were planted to cotton.

Trials of maize, groundnut, sorghum and soya bean varieties were carried out at Chitala for the Department of Agriculture.

Appendix.

Origin and Special Characteristics of the Main Cotton Strains Mentioned.

CLB	Crown Land Bulk, the commercial cotton in Nyasaland, mainly of U4 origin.
CL20	A selection from CLB with better lint quality.
Albar	A general term for selections from Nigerian Allen, highly resistant to bacterial blight. Two series of selections have been made, Albar 49 in 1949, and Albar 51 in 1951.
A637, etc.	Selections made at Namulonge from Albar 51, chosen as suitable for Nyasaland conditions.

Received February 1957.

Extracts from a Report on a Visit to Nyasaland and Southern Rhodesia, May-June 1956.

BY

E. O. PEARSON.

(Included by courtesy of the author, with official approval)

The Background to the Situation in Nyasaland.

Cotton is grown in Nyasaland in three main areas: (a) the Lower Shire Valley (commonly called the Lower River), which lies at an altitude below 200 ft., (b) the Central Shire and Lake Shore areas, at

1,500-2,000 ft., and (c) the Northern Province, at 1,600 ft. The last is a floodland area where cotton is grown in the dry season, and does not concern this report; in both former areas cotton is now a rainfed crop, planted in November-January and harvested in June-July, the legal close season being August-October.

The principal insect pests are red bollworm (*Diparopsis castanea* Hmps.) and two species of cotton stainer (*Dysdercus fasciatus* Sign. and *D. intermedius* Dist.), with jassid (*Empoasca facialis* Jac.) of less importance. The only disease of importance is bacterial blight (caused by *Xanthomonas malvacearum* E. F. Sm.), apart from stainer-borne internal boll disease caused by *Nematospora* spp.

Detailed investigations of red bollworm were made between 1939 and 1945. At that time, as to-day, by far the greater part of the cotton crop was produced in the Lower River, and red bollworm damage was there particularly severe. Work was accordingly concentrated on the problem in that area. In their report on that work, Pearson and Mitchell explain that *Diparopsis* is able to carry over from one cotton season to the next by means of long-term pupae formed in the soil, from which moths emerge during the following rainy season. The emergence, which is largely independent of the date of pupation, shows in the Lower River a first peak in December and a second, and usually much larger one, in March-April.

It was suggested that red bollworm could be completely controlled in the Lower River by delaying planting so that long-term pupae completed their emergence before any food was available from the new crop. This would imply growing the whole crop on irrigated or seasonally flooded land, which would not be possible until the flow of the Shire River can be controlled. It was recommended as an interim measure that cotton should be grown in such a way as to limit fruit production to that time of year when, it was believed, only short-term pupae would be produced. This involves planting the cotton early, under conditions promoting the maximum rapidity of development, and cutting it out in July in order to avoid the flush of fruiting that accompanies the August rise in temperature. The legal crop season in the Lower River would in this way be brought into line with that of the Central and Lake Shore areas, but it was expected that such a régime would be more effective against the pest in the former area than in the latter ones. This is because, at the higher altitudes, (a) formation of long-term pupae begins rather earlier in the calendar year, and thus some considerable production of carryover pupae cannot be avoided, and (b) emergence of moths from long-term pupae tends to be uni-modal, with a peak in January, so that the full onslaught is felt before the plant has had time to set a crop of bolls.

Early planting and early uprooting of cotton were introduced into the Lower River as Government policy in the 1951-52 season. There

had been a very poor crop in 1951, due to a drought that had prevailed from February onwards, and advantage was taken of this to introduce the new régime without preceding it by the non-cotton year that would otherwise have been necessary. In order to promote the rapid growth and early setting of the crop that is the essential feature of this method of bollworm control, the interplanting of cotton in maize was prohibited and the whole cotton crop was grown in pure stand. One of the major difficulties foreseen by the authors of the 1945 report was thus removed, by a bold and, as it turned out, successful stroke.

A very marked improvement in yield on the Lower River has followed this change of régime, and has been more than enough to offset any fall in the acreage planted. Estimates of yield of seed cotton per acre in 1951-52 and 1952-53 were of the order of 500 lb., more than three times the average recorded in 1939-44, and in the four seasons so far completed under the new régime the total production in the Lower River has ranged between 5,000 and 7,300 tons of seed cotton. The latter figure has only once been exceeded in the history of the Lower River.

The benefits of the change in régime on the Lower River have, however, been offset latterly by an increase in the proportion of cotton bought as grade 2. Over the whole of the Lower River, the percentages of grade 2 in the four seasons 1951-52 to 1954-55 have been 9·6, 20·6, 20·2, and 31·1*. The bulk of the staining in this grade 2 cotton appears to have been due to stainer-borne *Nematospora*, and in the last of these four seasons, some 50 per cent. of the seed from the grade 1 cotton was not viable, suggesting continued heavy infestation by stainers after the bolls had passed the stage at which the lint could be affected. These figures compare with an average of about 15 per cent. grade 2 cotton in the five years 1940-44 under the previous régime.

Numerical records of the stainer populations in cotton in recent years are not available but it appears that immigration of adults of *D. intermedius* and (somewhat later) *D. fasciatus* has occurred in February and that populations subsequently bred in the crop have been extremely high. This is in marked contrast to the situation that prevailed previously.

The preceding paragraphs refer principally to the Lower River areas. Until comparatively recently it had been believed that with December sowing and with harvesting completed by the end of July, infestations by red bollworm in the Central and Lake Shore areas could be satisfactorily contained. Thus in 1952 it was reported that "the close season with a minimum of three months . . . . has resulted in good control of red bollworm . . . . experience at the Cotton Experiment

*These figures have been calculated from rough totals of individual market figures kindly supplied by the Cotton Marketing Board, excluding certain doubtful records which I have not been able to verify.

Station (Lake Shore area) suggests that this can be maintained indefinitely . . . . provided there is no relaxation of control measures". The attacks of red bollworm in the three years that followed were so severe, however, as to lead to a reversal of this appreciation of the situation, and in 1955 it was stated that "in the central areas represented by Chitala (the Cotton Experiment Station), the close season measures at present in use do nothing appreciably to control the ravages of red bollworm".

Over the same period there has also been an increase in the populations of *Dysdercus* infesting cotton, with a corresponding rise in the amount of stained cotton. It had always been realised that considerable infestations of *Dysdercus* were liable to be bred up in cotton in the Central areas, but that, provided the crop was formed rapidly, the bulk of the bolls would mature before the stainer infestation became serious. Crops retarded, e.g. by bollworm infestations, would be liable to heavy stainer damage, and this appears to be what has happened since 1952.

Considerable attention has been paid in recent years to the occurrence in the Nyasaland crop of bacterial blight, which previously had not been considered to be of importance in the territory. This was particularly the case in the Lower River under the old régime, when, although bacterial infection was common in bolls that had been damaged by insects, loss of flower buds and bolls due to direct bacterial infection was noticeably rare. In the Lake Shore area, although the angular leaf spot and blackarm phases have been sufficiently severe in occasional, very wet seasons to show up inter-strain differences in susceptibility, bacterial boll disease has never been recorded as accounting for more than a small percentage of the crop set, although it has been thought that it might be a cause of excessive shedding. The possibility of the disease attaining serious proportions under the summer crop régime in the Lower River was envisaged by Ducker in 1952, and two years later Wickens drew attention to the fact that although the crop at the time of his visit (February 1954) had suffered but little from the angular leaf spot, vein blight and blackarm phases that were then prevalent, the greatest danger lay in later possible loss of crop through bacterial boll disease.

The Situation in Nyasaland in Early June 1956.

Throughout the Lower River the cotton seen had grown well and comparatively regularly; there was a noticeable absence of the crop failures, due to late planting or excessive maize competition, that used to be common under the old régime and of the excessively woody, tangled growth that was previously associated with early planting. Plants on the whole were well formed and, although robust, were not

unduly large. Their most striking feature was the extent to which a crop of bolls had been set at the base and in the centre of the plant. This was particularly the case from Chiromo and Ngabu southwards, where the bulk of the bolls that would open had done so, and plants were becoming senescent, with relatively little sign of a top crop. Northwards from Ngabu, into the main part of Chikwawa district, there had been rather more loss of fruiting points at the base of the plants, and the crop had thus been set later, and was present in all stages, from open bolls to partly grown green bolls and flowers. Such fields were still carrying abundant green leaf, but there were relatively few that still showed signs of vigorous recent growth.

Red bollworm larvae could be found in the green bolls, but not very readily, and there was only slight evidence of their activity in bolls that had opened or aborted. This was the case even in fields where early shedding had been heavy, and suggested that such shedding might not have been caused by bollworm. At this stage in the season it is difficult to get good evidence of what has happened earlier on, but examination of the oldest sheds that could be found on the ground below the plants did not show a preponderance of bollworm damage. I was satisfied, in short, that the incidence of bollworm in most of the Lower River crop is not now sufficient to prevent the formation of a large, early, potential crop of bolls, and that the main object of the early cropping régime has been achieved.

This potential crop, however, was very far from being realised. A large proportion of the bolls that had set had failed to open properly, if at all, and of the locks that were pickable, a very high proportion were stained. I should be surprised if the proportion of grade 2 cotton from the current crop was not even higher than that recorded in 1955, and it must be emphasized that this only represents a proportion of the real loss, which is mainly in the form of bolls that do not open at all or that produce locks that are unpickable.

The primary cause of the bad opening was undoubtedly attack by stainers, which had evidently started before boll-opening and had thus caused not merely discoloration of the lint but, to a much greater extent, abortion of the lock. Any green bolls present were heavily punctured and infected.

The damage caused by stainers to bolls low down on the plant had been partly obscured by secondary infections favoured by late rain, which had also been directly responsible for flattening and matting the lint in bolls that had not opened well, but that in dry, sunny weather would have yielded some pickable cotton. These secondary effects account for the widespread and very natural belief that the crop had been spoilt by wet weather.

There were considerable populations of *Dysdercus intermedius* and *D. fasciatus* present in the cotton fields, chiefly as late instar nymphs

and freshly moulted adults. The former species was usually the more numerous. Except where the early fruiting points had been lost and the crop had therefore been set late, and thus showed all stages of boll development, including recently opened bolls in which early instar nymphs were abundant, the stainer populations appeared to be dispersing. In some fields the populations left seemed inadequate to account for the damage exhibited by the crop; in such cases few sound seeds could be found and it seemed likely that stainers had exhausted their food supply and left.

A feature of the Lower River crop that was unfamiliar to me from past experience was the extent of bacterial blight. In parts of the Ngabu area, and in West Chikwawa, this took the form of classical blackarm, with vein lesions and truncation of the fruiting branches, but the boll disease phase was widespread, not only in association with bollworm punctures but also, and principally, as direct lesions, particularly at the base of the boll. I suspect that where early shedding had been severe, a considerable amount of it may have been due to bacterial disease.

Mention has previously been made of the comparative rarity of direct damage by bacterial blight under the old régime. Under that régime cotton was not sown until mid January or very often later. By then, infected trash from the previous year's crop had been exposed to upwards of two months' rain, and may therefore have suffered considerable destruction of the pathogen, even though there is some doubt as to how complete such destruction may be, or as to the precise mechanism by which moisture causes it. Moreover, under the old régime, practically the whole cotton crop was intersown in maize, and thus very largely protected from the rain-splash and driving storms that are responsible for disseminating and promoting bacterial infection. Under the new régime, the cotton is planted in pure stand on the earliest rains, and is thus far more liable than in the past to infection from the previous year's debris, particularly as crop rotation is as yet little practised. In 1956, the rainfall in the early part of the season was distinctly scanty, but later on was heavy and protracted, being exceptional in April and maintained throughout May, right up to the time of my visit. Precisely the conditions had been provided, in fact, that Wickens had foreseen in 1954 as liable to lead to an outbreak of bacterial boll disease.

The general pattern of events in the cotton crop in the Central and Lake Shore areas visited (Lisungwe, Balaka and Chitala-Salima) did not seem essentially different from that described above, although the plants had reached a more advanced state of senescence. The principal feature was an increase in the intensity of the attack by red bollworm as one moved north: at Lisungwe this had been relatively light, but

stainer had been very severe; at Balaka (where all the cotton seen was on the Rivi-Rivi estate of the Nyasaland Farming Corporation), bollworm had apparently caused considerable early shedding and damaged about 50 per cent. of the bolls that had set, although multiple infection with stainer and bacterial disease would in any case have destroyed most of the latter; at Chitala, early shedding had been very serious, and many plants had held no bolls at all. Plants at Chitala had grown very big and some had succeeded in maturing a middle crop that had opened fairly cleanly; above this, however, everything had been ruined by stainer, and there was a very large population of both *D. fasciatus* and *D. intermedius* present, in all stages of development.

The incidence of bacterial blight was particularly severe on the Chitala experiment station, affording a valuable contrast between the behaviour of the strains and selections out of Crown Land Bulk (CLB) and that of the blackarm resistant Albar strains and panmixis bulks. The CLB strains showed typical blackarm symptoms, particularly severe in an exhaustion plot experiment, and, amongst the shed material, there was a considerable preponderance of fruiting forms that did not show bollworm damage. The Albar strains, on the other hand, had held very much more of the early crop and, having opened this (or such of it as had not subsequently been damaged by stainer) had reached a state of natural senescence, contrasting with the more sustained, ranker growth of the susceptible strains. This observation strengthened my suspicion that a substantial part of the early shedding that had been seen in the Lower River may have been due to bacterial boll disease, and not to red bollworm.

Discussion.

This brief and necessarily rather superficial survey of the main cotton growing areas of Nyasaland this season has nevertheless enabled the following conclusions to be formed:—

(1) The new régime in the Lower River is giving sufficient control of red bollworm to permit the setting of a very large potential crop.

(2) In the remainder of the summer crop areas, the same cropping régime is not sufficient by itself to prevent serious red bollworm infestations.

(3) Infestations of cotton stainers have everywhere this year, and particularly in the Lower River, been so high as to destroy a large part of the potential crop set.

(4) Bacterial blight is a factor that must everywhere be reckoned with, at any rate in years of late rains.

As regards red bollworm, there is no room for further manipulation of planting and uprooting dates as a means of controlling the pest in raingrown cotton. It was always recognised that the early cropping system on the Lower River would inevitably continue to produce some long-term pupae, and that their effective survival to the next year's crop should be minimised by the early digging or ploughing of old cotton fields and by mulching. A spread of the use of draught oxen would help here. It is extremely important that the present uprooting date be maintained. Requests for its postponement are never made except in the particular circumstances that make its enforcement essential—namely, the existence of a crop of green bolls at a time of year when they are certain to give rise to carryover pupae.

For further mitigation of red bollworm attack one can look only to biological or to chemical control. The former would depend mainly on the possibility of finding a suitable parasite of the South American cotton bollworm, *Sacadodes pyralis* Dyar; there is a further possibility that parasites of the Sudan bollworm, *Diparopsis watersi* (Roths.), might be effective against the Southern African form. The possibility of chemical control would depend on an intensification of the work that has shown promise in Southern Rhodesia, and its application to African grown crops.

Insecticidal experiments against red bollworm have been made at Gatooma for a number of years, but have only recently given definite results. In the past two seasons and the present one, trials have shown that the use of DDT and BHC mixtures, Parathion alone and with DDT, and Endrin alone, can give very large percentage increases in yields, particularly when applied at the start of flower bud formation, in the form of emulsions, and at weekly intervals over a period of two months. The best yields resulting have been of the order of 600 lb. seed cotton per acre as against a little over 100 lb. on untreated controls. The approach in these trials has been an empirical one, and it is difficult to draw conclusions from them on many of the most vital points (e.g., formulations, methods of application), but they are of very great importance in demonstrating that it is possible to effect some control of *Diparopsis* by chemical means.

The recent prevalence of stainer damage in the Lower River crop suggests that in avoiding one pest we have run into another. During the early part of the rainy season, stainers breed on the old shed seed of a number of arboreal host plants, notably baobab (*Adansonia digitata*), *Sterculia appendiculata* and *S. quinqueloba,* and on the newly-ripened fruits of *S. africana* and the kapok, *Ceiba pentandra.* Under the old régime, invasion of the cotton crop did not occur until April-May and this was probably derived from a generation intervening on herbaceous hosts (chiefly *Hibiscus* spp.) which are not very

numerous, and which in consequence did not give rise to any large invasion of cotton. In the present changed circumstances, cotton must provide a large food supply available directly to the generation bred in the early rains on arboreal hosts. The fact that stainer damage was only slight in the first season of the new régime (1951-52) argues against this hypothesis. The progressive nature of the rise since then, however, suggests another possibility. An ample food supply now intervenes at a time when climatic conditions are most suitable to breeding, and at a time when, in the past, there had been somewhat of a gap in the sequence of stainer food plants. As a result, the whole stainer population of the Lower River may have increased and, while still fluctuating seasonally, may be doing so at a much higher level than was the case before.

Against this suggestion that serious damage by stainer is an inevitable sequel to control of red bollworm by early cropping is the fact that increased damage by stainer has not been confined to the Lower River, but has occurred in the Central and Lake Shore areas, where there has been no change in planting dates, both in the present (1955-56) season, and in the 1954-55 one. An explanation might be sought in the weather: the protracted rains of the present year have undoubtedly fostered stainer multiplication in both areas, and the same holds for the Lower River and Central areas in 1954-55. In that year the Lake Shore crop was late planted and provided an opportunity for a large build-up of stainer in the crop. Whatever the cause of the severe staining recently encountered throughout the summer crop areas, it merits investigation. The object should be (1) to determine more accurately than is at present known the sequence of breeding on wild host plants, (2) to investigate the possibility of breaking that sequence by eradication of one or more arboreal hosts, or of the stainer populations on them, (3) to investigate the possibility of direct control of stainers on cotton with insecticides.

The incidence of substantial infections of bacterial blight in the Lower River crop seems very likely to be bound up, as suggested previously, with the altered cropping régime.

Whether there has really been a general increase in incidence in the rest of the summer crop areas, or whether this reflects a succession of seasons peculiarly favourable to the disease, accompanied possibly by a greater awareness of its potentialities for damage, is a matter for speculation. It is perfectly clear, however, from this season's experience, that it will be, at the very least, a valuable insurance to concentrate on the selection and multiplication of blackarm resistant strains, and in the meantime to continue seed treatment of the commercial seed supply.

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